GEOLOGY, ENERGY, AND MINERAL (GEM) RESOURCE ASSESSMENT OF THE SWEETWATER CANYON GEM RESOURCE AREA (GRA), WYOMING, INCLUDING THE SWEETWATER CANYON WILDERNESS STUDY AREA (WY-030-101)

PHASE I

Contract No. YA-553-CT2-1055

Prepared for:

U.S. Bureau of Land Management

Prepared by:

Tetra Tech, Inc.
Pasadena, California

September 1983

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EXECUTIVE SUMMARY

The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data concerning Wilderness Study Areas (WSAs). To facilitate this review, certain WSAs with similar geologic environments and mineral characteristics have been grouped into larger GEM Resource Areas (GRAs). Using these guidelines, the Sweetwater Canyon WSA was grouped into the larger Sweetwater Canyon GRA. This report, which terminates the Phase I activities for the Sweetwater Canyon GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the WSA.

The Sweetwater Canyon GRA contains one WSA, the Sweetwater Canyon WSA (WY-030-101). The Sweetwater Canyon WSA is located in the BLM's Lander Resource Area, Rawlins District, Wyoming.

The Sweetwater Canyon WSA is considered to have a moderate favorability based on direct but quantitatively minimal evidence for the potential occurrence of gold and other metallics (classified 3C). Gold and other metallics may occur in bedrock and surficial deposits. Within bedrock, gold-quartz-arsenopyrite veins may occur within the Precambrian rocks that crop out in the WSA (Prinz, 1974; Bayley, Proctor, and Condie, 1973). Gold and other heavy minerals may occur as fossil placers in the basal Flathead Formation, and as Recent placers in the alluvium of the Sweetwater River (field verification). The WSA is considered to have a low favorability based on direct but quantitatively minimal evidence for the potential occurrence of sand and gravel (classified 2C). The WSA is also considered to have a moderate to low favorability based on indirect and insufficient direct evidence for the potential occurrence of uranium and thorium (classified 3A and 2B) (field verification).

The Sweetwater Canyon WSA is considered favorable for the occurrence of the above mentioned GEM resources for the following reasons: past production of gold from placers, the adjacent Atlantic City-South Pass and Lewiston lode districts, abundant unpatented claims, and the presence of favorable geologic environments for the occurrence of some GEM resources.

Quantitatively minimal direct evidence exists to support a low favorability classification of the potential occurrence of other GEM resources (classified 2C). This classification is based on the geologic environment and the inferred geologic processes that have been identified in the WSA.

Additional geologic investigations would supplement the GEM resource evaluation of the Sweetwater Canyon GRA. Additional geologic mapping and geochemical sampling would help provide more accurate information to assist in making wilderness decisions. A moderate amount of geologic information exists which needs to be reviewed by BLM personnel to gain additional insight into the potential occurrence of GEM resources within the WSA prior to making wilderness decisions.

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GEM RESOURCE AREA
SWEETWATER CANYON

1.0 INTRODUCTION

1.1 Purpose of Study

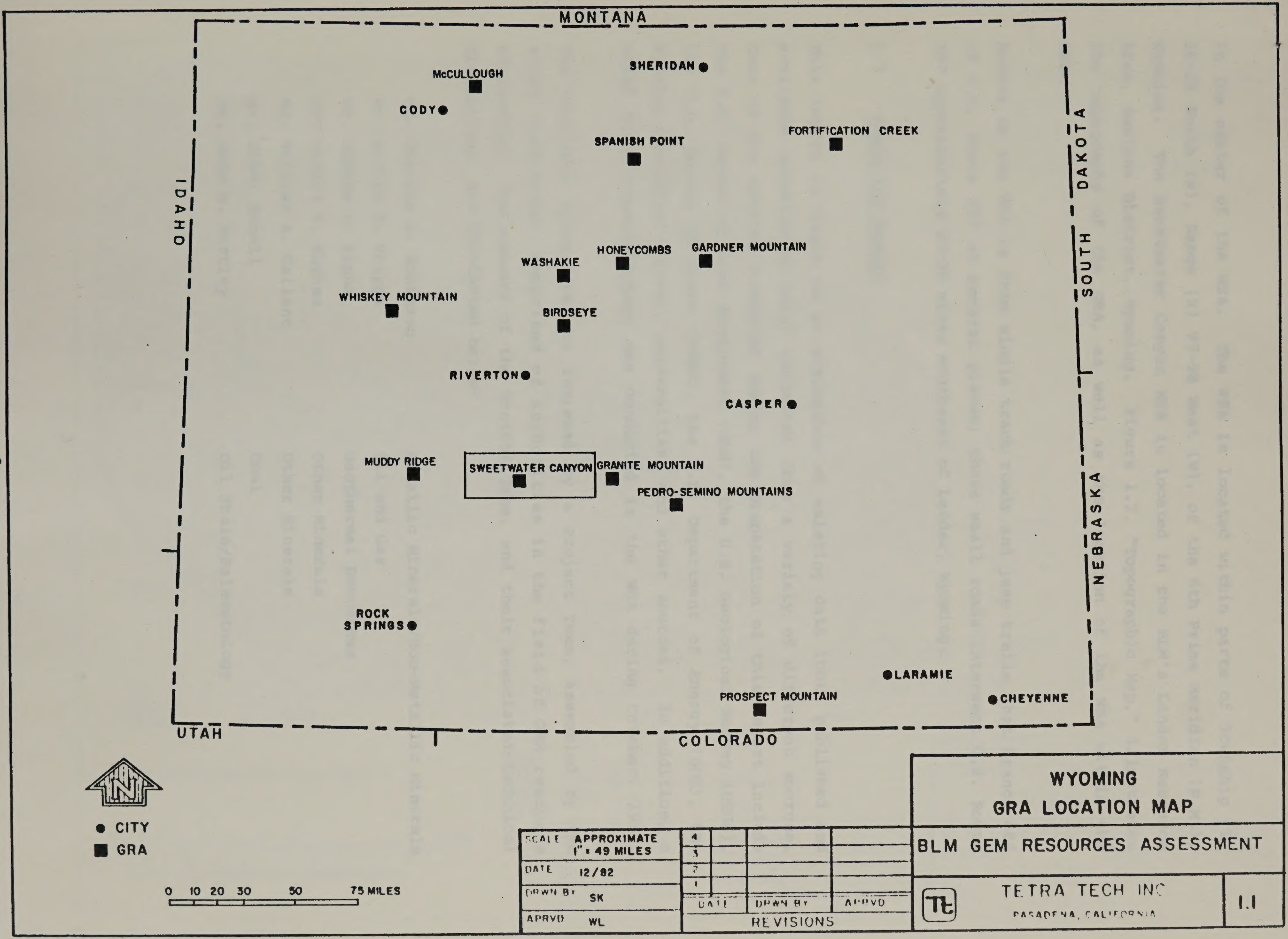
The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data for suitable/nonsuitable decisions concerning Wilderness Study Areas (WSAs). Phase I consists of a review and evaluation of existing data, resulting in an interpretation of the GEM resource potential of the WSA. Phase II is designed to generate only the additional data required to support the GEM resource recommendations presented during Phase I. To facilitate this review, certain WSAs with similar geologic environments and mineral characteristics have been grouped together into larger GEM Resource Areas (GRAs). Using these guidelines, the Sweetwater Canyon WSA was combined into the larger Sweetwater Canyon GRA. This report, which terminates the Phase I activities for the Sweetwater Canyon GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the Sweetwater Canyon WSA.

The GEM resource evaluations for this study were performed by Tetra Tech, Inc. for the U.S. Bureau of Land Management, under Contract No. YA-553-CT2-1055. This study was completed in January, 1983.

1.2 Location and Access

This GEM report covers the area identified as the Sweetwater Canyon GRA; the geographic location of the study area is shown in Figure 1.1, "GRA Location Map."

The Sweetwater Canyon Area GRA, because of its remote location, contains only the Sweetwater Canyon WSA (WY-030-101). The Sweetwater Canyon WSA contains 9,056 acres and is located between 42° 23' and 42° 28' north latitude, and between 108° 23' and 108° 32' west longitude; Sweetwater Canyon is located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IDAHO
SOUTH DAKOTA
NEBRASKA
UTAH
COLORADO
McCULLOUGH
CODY
SHERIDAN
SPANISH POINT
FORTIFICATION CREEK
WASHAKIE
HONEYCOMBS
GARDNER MOUNTAIN
WHISKEY MOUNTAIN
BIRDSEYE
RIVERTON
CASPER
MUDDY RIDGE
SWEETWATER CANYON
GRANITE MOUNTAIN
PEDRO-SEMINO MOUNTAINS
ROCK SPRINGS
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PROSPECT MOUNTAIN
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WYOMING
GRA LOCATION MAP
BLM GEM RESOURCES ASSESSMENT
TETRA TECH INC
PASADENA, CALIFORNIA
1.1

in the center of the WSA. The WSA is located within parts of Township (T) 28-29 North (N), Range (R) 97-98 West (W), of the 6th Prime Meridian (P.M.), Wyoming. The Sweetwater Canyon WSA is located in the BLM's Lander Resource Area, Rawlins District, Wyoming. Figure 1.2, "Topographic Map," illustrates the topography of the GRA, as well as the location of the WSA within the GRA.

Access to the WSA is from single track roads and jeep trails that branch off of U.S. Route 287 at several places; these small roads intersect U.S. Route 287 approximately 20-30 miles southeast of Lander, Wyoming.

1.3 Basis for Report

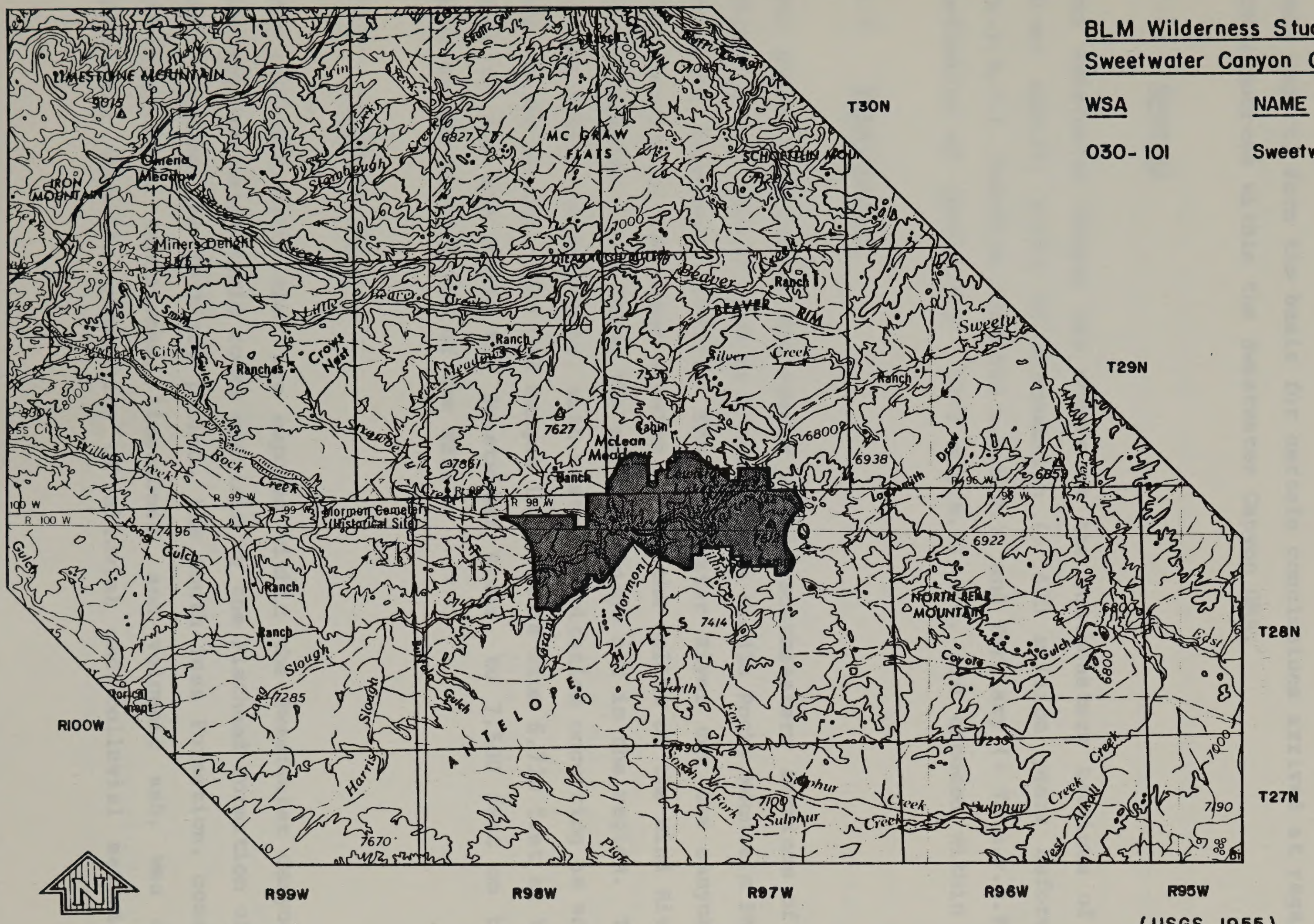
This report is based on an evaluation of existing data (both published and available unpublished data) collected from a variety of different sources. Some of the sources contacted during the preparation of this report include the U.S. Bureau of Land Management (BLM), the U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), the U.S. Department of Energy (DOE), the Wyoming Geological Survey, universities, and other sources. In addition, a brief field reconnaissance was conducted in the WSA during October, 1982.

The available literature was reviewed by a Project Team, assembled by the study contractor, comprised of authorities in the field of GEM resource evaluation. The members of the Project Team, and their associated technical disciplines, are identified below:

Mr. Charles S. Robinson	Metallic Minerals/Non-Metallic Minerals
Mr. Rollin E. Phipps	Oil and Gas
Mr. Andrew G. Alpha	Geothermal Resources
Mr. Stuart P. Hughes	Other Minerals
Mr. William A. Gallant	Other Minerals
Mr. Elmer Schell	Coal
Mr. John A. Hartley	Oil Shale/Paleontology

BLM Wilderness Study Areas Included in the Sweetwater Canyon GRA·

WSA	NAME	ACREAGE
030-101	Sweetwater Canyon	9,056



(USGS, 1955)

NOTE: Contours In 200ft. Intervals

▨ Approximate Boundary of Wilderness Study Area

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

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Sweetwater Canyon GRA, Wyoming

TOPOGRAPHIC MAP

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FIGURE
1.2

2.0 GEOLOGY

The geology of the area is illustrated on the state geologic map and other maps (Love, Christiansen, and Jones, 1979; Bell, 1955; and Denson and Pipiringos, 1974). These maps, together with the brief field reconnaissance and other data presented in the references and selected bibliography section of this report, form the basis for certain conclusions arrived at regarding the GEM resources within the Sweetwater Canyon GRA.

2.1 General

The Sweetwater Canyon WSA occurs at the southeastern terminus of the Wind River uplift; rocks of Precambrian (> 600 million years before present (m.y.B.P.), Cambrian (500-600 m.y.B.P.), and Tertiary (< 70 m.y.B.P.) age, and sediments of Quaternary (2-3 m.y.B.P) age, are exposed within the WSA.

2.2 Physiography

The Sweetwater Canyon WSA occurs at the southeastern terminus of the Wind River uplift, and as such is a part of the Middle Rocky Mountain Physiographic Province (Fenneman, 1931). The Sweetwater River cut the canyon that it now occupies by continued erosion during the uplift of the Wind River range; the Sweetwater River forms the major drainage net in the region. The climate in the region is semi-arid, with most precipitation occurring as snow during the winter months. The WSA ranges in altitude from 6,720 feet at the eastern edge of the WSA along the Sweetwater River, to 7,500 feet on the upland area at the western end of the WSA.

2.3 Geologic Units

The geologic units that are exposed within the Sweetwater Canyon WSA are Precambrian metamorphic rocks overlain by the Flathead Formation of Cambrian age. During the Tertiary period, the South Pass Formation, consisting of conglomerates, sandstones, limestones, and volcanic ash, was deposited. Surficial deposits consisting of alluvial and colluvial materials cover

portions of the previously described bedrock units. Figure 2.1, "Geologic Map," delineates the geologic formations that occur throughout the GRA. Figure 2.2, "Generalized Stratigraphic Column," is a generalized stratigraphic column that gives a brief description of all the stratigraphic units that underlie the Sweetwater Canyon GRA.

2.3.1 Bedrock Units

The major bedrock formation that underlies the Sweetwater Canyon WSA is a group of undifferentiated Precambrian granites, gneisses, and metavolcanics. Available geologic mapping of the region loosely differentiates between the different types of Precambrian rocks that are readily identifiable in the field (Bell, 1955). The contacts, however, are not accurately plotted or complete.

The Flathead Formation crops out in the northeast portion of the WSA; at this point, it dips approximately 20° to the northeast and uncomformably overlies the Precambrian rocks. The unit consists of approximately 200 feet of interbedded maroon to white quartz pebble conglomerate, crossbedded sandstone, and quartzite (field verification).

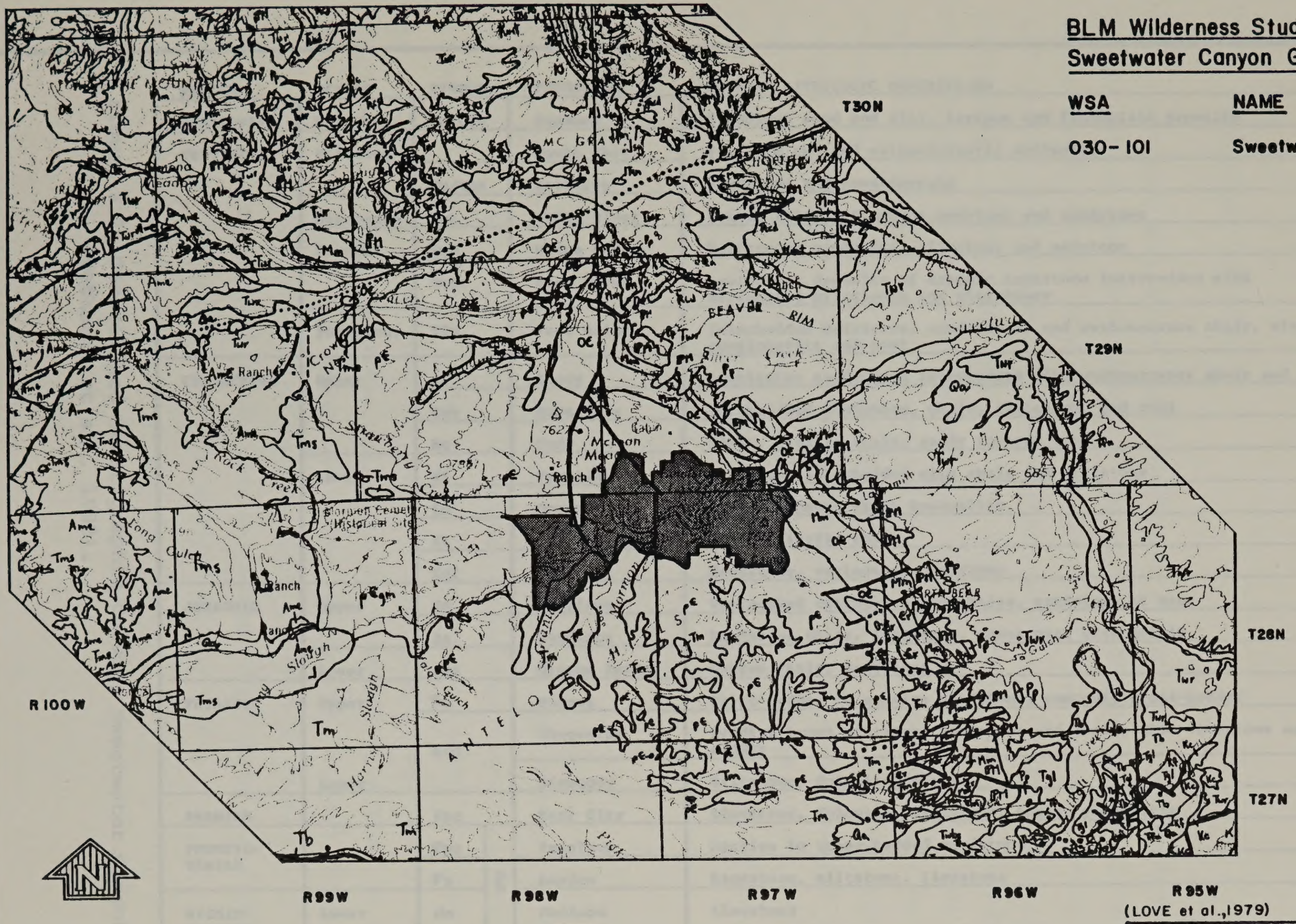
Overlying the Precambrian rocks and Flathead Formation in the WSA are outcrops of the South Pass Formation of Pliocene (1-11 m.y.B.P.) age. The South Pass Formation of Pliocene age consists of a thin veneer of conglomerates and sandstones, the clasts of which are derived from Precambrian rocks cemented with volcanic ash. In addition, beds of volcanic ash are also found in the area.

2.3.2 Surficial Deposits

The field reconnaissance of the study area identified several types of surficial deposits, including alluvium and colluvium. Alluvium, consisting of boulders, gravel, sand, silt and clay, has been deposited by the Sweetwater River in Sweetwater Canyon and its tributaries. Lag gravel deposits are found scattered over the topographic surface above Sweetwater Canyon. These gravels

BLM Wilderness Study Areas Included in the Sweetwater Canyon GRA

WSA	NAME	ACREAGE
030-101	Sweetwater Canyon	9,056



▨ Approximate Boundary of Wilderness Study Area

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

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Sweetwater Canyon GRA, Wyoming

GEOLOGIC MAP

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FIGURE 2.1

SYSTEM	SERIES	SYMBOL		FORMATION	GENERAL LITHOLOGIC DESCRIPTION
QUATERNARY	Holocene	Qa/Qls		Unnamed	Windblown sand and silt, terrace and floodplain deposits
TERTIARY	Pliocene			South Pass	Volcanic ash and volcaniclastic sediments
		Tm/Tms		Arikaree	Sandstone and conglomerate
	Ologocene	Twr		White River	Vitric tuff, tuffaceous mudstone and sandstone
	Eocene	Twb		Wagon Bed	Tuffaceous sandstone, siltstone and mudstone
		Twdr		Wind River	Lenticular deposits of arkosic sandstone interbedded with variegated siltstones and claystones
	Paleocene	Tfu		Fort Union	Interbedded mudstones, sandstones, and carbonaceous shale, minor conglomerate and coal
CRETACEOUS	Upper	Kl		Lance	Lenticular sandstones interbedded with carbonaceous shale and coal
		Kmv		Mesaverde	Interbedded sandstone, shale, siltstone, and coal
		Kc		Cody	Black, fissile shale, sandy towards top
	Lower	Kf		Frontier	Sandstone interbedded with shale and siltstone
		Km		Mowry	Gray siliceous shale bentonitic
		Kt		Thermopolis	Black, fissile shale
		Kcl		Cloverly	Sandstone, variegated claystone
JURASSIC	Upper	Jm		Morrison	Variegated claystones and shales, sandstone at base
		Js		Sundance	Sandstone shale, limestone, upper part glauconitic
	Lower	Jgs		Gypsum Spring	Gypsum shale, sandstone
TRIASSIC	Upper	T̄Rn		Nugget	Thick-bedded to massive sandstone, commonly cross-bedded
		T̄Rcd		Chugwater	Reddish-brown siltstone sandstone and shale; thin limestone near middle
	Lower			Dinwoody	Siltstone, dolomite, shale
PERMIAN		Ppc		Park City	Limestone, dolomite, siltstone, shale, phosphatic
PENNSYL-VANIAN		IPpc	PM	Tensleep	Massive to cross-bedded sandstone
		IPa		Amsden	Sandstone, siltstone, limestone
MISSIS-SIPPIAN	Lower	Mm		Madison	Limestone
DEVONIAN	Upper	Dd		Darby	Limestone, sandstone
ORDOVICIAN	Upper	Ob	€O	Bighorn	Massive dolomite
CAMBRIAN	Upper	€g		Gallatin	Limestone, shale, limestone pebble conglomerate
	Middle	€gv		Gros Ventre	Sandstone, shale, limestone pebble conglomerate
		€f		Flathead	Red-brown sandstone, quartzite
PRECAMBRIAN		P€/Amc p€r p€gn			Granite schist, gneiss

Figure 2.2 Generalized Stratigraphic Column, Sweetwater Canyon, GRA (Gebhardt et al., 1982).

are the result of either direct erosion of the Precambrian and younger rocks, or erosion from the South Pass Formation which crops out in the area. These deposits are thin and unevenly distributed. Colluvial deposits occur in the form of talus along the base of canyon walls. Colluvium, bedrock weathered in place, occurs adjacent to outcrops.

2.4 Structural Geology

The structural geology of the Precambrian rocks in the study area is complex. The foliation and fracturing of the biotite gneisses which crop out in the western part of the WSA are host for quartz veins; these quartz veins have been past gold producers in the adjacent Atlantic City-South Pass and Lewiston districts. Cross fractures across the foliation may be likely sites for the migration of mineralizing solutions remobilized from the mineralized quartz veins or by later mineralizing episodes. The unconformity between the Precambrian rocks and Flathead Formation may be a potential site for fossil placers or uranium mineralization remobilized from a Precambrian source rock. The Flathead Formation has been the host for uranium mineralization in the southeastern end of the Atlantic City-South Pass District and in other areas of the state.

2.5 Engineering Geology

Several geologic hazards were identified in the WSA during the field reconnaissance. Swelling soils and boggy conditions associated with areas of weathered volcanic ash occur on the upland areas above the canyon. Within the canyon, flood hazards and bank erosion along the channel and adjacent floodplain of the Sweetwater River can be expected from time to time. Rockfall hazard is evident along the steep canyon walls, and debris flows may occur associated with short term, high intensity rainfall in the canyon tributaries. Some small landslides may be expected along the dip slope of the Flathead Formation in the eastern portion of the WSA.

2.6 Paleontologic Resources

No known paleontologic localities have been identified in the area. The Tertiary South Pass Formation has the potential for some vertebrate remains, but none have been identified within the WSA.

2.7 Historical Geology

The geologic history of the Sweetwater Canyon area begins with the metamorphism of Precambrian sedimentary and igneous rock into the assemblage of biotite and granite gneisses. Several periods of deformation, between 2.7 and 3.3 billion years ago, and the intrusion of granitic magmas caused contact metamorphic effects with the intruded rocks. The primary gold-quartz mineralization probably occurred prior to the intrusion of the granitic magmas in the Atlantic City-South Pass District to the northwest (Hausel, 1980). Later, during the Precambrian, mafic dikes were intruded along zones of weakness in the older rocks.

After a period of erosion, a fluvial environment with rapid streams swept the area and deposited quartz pebble conglomerates and sandstones of the Flathead Formation. Since portions of gold quartz veins may have been exposed during this erosion cycle, heavy mineral concentrates or fossil placers may have been deposited sporadically in the basal Flathead Formation. These heavy mineral concentrates derived from the abundant Precambrian rocks that were exposed may have contributed other elements as heavy concentrates (i.e., iron, uranium, rare earths, etc.). After the Flathead Formation was deposited, the remaining Paleozoic (225 m.y.B.P.) and Mesozoic (70-225 m.y.B.P.) rocks were deposited over the Cambrian and Precambrian rocks.

During the Laramide uplift (90 m.y.B.P.) the erosion of the Wind River uplift gradually eroded older and older rocks until the Precambrian and Cambrian Flathead Formations were exposed. The Laramide uplift triggered a period of active erosion and deposition during the Tertiary age; during this period thousands of feet of Tertiary fluvial materials were eroded and deposited into

the subsiding Wind River and Great Divide basins. Only thin Tertiary deposits were deposited on the more active uplifted areas, as in the Sweetwater Canyon WSA.

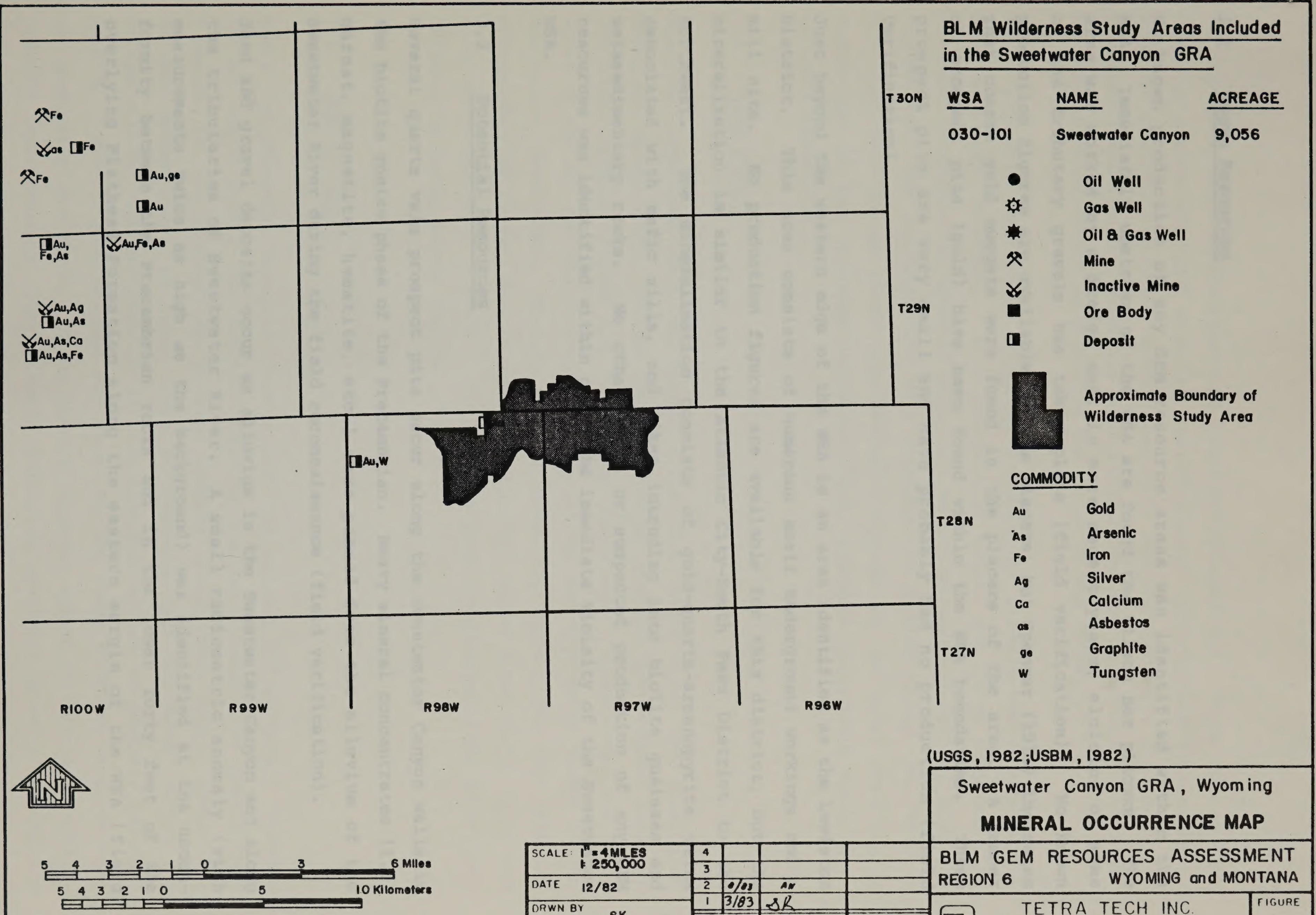
After the uplift of the mountain ranges reached a point when deposition was overtaken by erosion, and an established stream network was developed, the Sweetwater River system gradually eroded down through the Tertiary sediments to expose and cut the Sweetwater Canyon. During recent times, the Precambrian rocks were eroded from the adjacent area and deposited as alluvium in the organized stream network of the region. The Atlantic City - South Pass City and Lewiston Districts, along with other adjacent gold-quartz veins, were exposed to erosion and thus gold was again concentrated in stream alluvium. Much of the gold recovered from the Wilson Bar placer, upstream of the Sweetwater Canyon WSA, originated in this way. Heavy mineral concentrates exist in the Sweetwater River alluvium within the WSA (field verification).

3.0 ENERGY AND MINERAL RESOURCES

3.1 General

The known resources of the Sweetwater Canyon WSA include gold and other heavy mineral concentrates, and sand and gravel in the alluvium of the Sweetwater River. Potential resources that may occur in the study area and associated with fracture zones include the following: gold-quartz veins in Precambrian metamorphic rocks; fossil gold placers and uranium in the basal Flathead Formation; and undefined metallic sulfide minerals and rare earths.

Figure 3.1, "Mineral Occurrence Map," illustrates the locations of the known past and present mines, and occurrences of mineral deposits and GEM resources within the GRA. The sources of information for this figure are the USGS' Computerized Resource Information Bank (CRIB), and the USBM's Minerals Availability System (MILS).



BLM Wilderness Study Areas Included in the Sweetwater Canyon GRA

WSA	NAME	ACREAGE
030-101	Sweetwater Canyon	9,056

(USGS, 1982; USBM, 1982)

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Sweetwater Canyon GRA, Wyoming

MINERAL OCCURRENCE MAP

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FIGURE
3.1

3.2 Known Resources

No known production of any GEM resource areas was identified within the WSA. Immediately upstream of the WSA are found the Wilson Bar placers. The area was worked by a dredge and, in more recent years, sluicing of some of the tributary gravels has taken place (field verification). No known production figures are available for the placers, but Spencer (1916) indicates that coarse gold nuggets were found in the placers of the area. A number of prospect pits (gold) have been found within the WSA boundaries. These prospect pits are very small and have probably had no production (field verification).

Just beyond the western edge of the WSA is an area identified as the Lewiston District. This area consists of numerous small underground workings and a mill site. No production figures are available for this district, but the mineralization is similar to the Atlantic City-South Pass District to the northwest. The mineralization consists of gold-quartz-arsenopyrite veins associated with mafic sills, and dikes intruding into biotite gneisses and metasedimentary rocks. No other known or suspected production of any GEM resources was identified within or in the immediate vicinity of the Sweetwater WSA.

3.3 Potential Resources

Several quartz vein prospect pits occur along the Sweetwater Canyon walls in the biotite gneiss phase of the Precambrian. Heavy mineral concentrates (i.e. garnet, magnetite, hematite, etc.) were panned from the alluvium of the Sweetwater River during the field reconnaissance (field verification).

Sand and gravel deposits occur as alluvium in the Sweetwater Canyon and along the tributaries of Sweetwater River. A small radiometric anomaly (with measurements twice as high as the background) was identified at the unconformity between the Precambrian rocks and in the lower forty feet of the overlying Flathead Formation along the eastern margin of the WSA (field

verification; instrument-Geometrics 101-A Scintillometer). There are several possible causes for this anomaly: heavy mineral concentrates consisting of thorium minerals; uranium associated with the unconformity in the Lower Flathead Formation; or potassium alteration along the unconformity. Further investigation is needed to determine the cause of the anomaly.

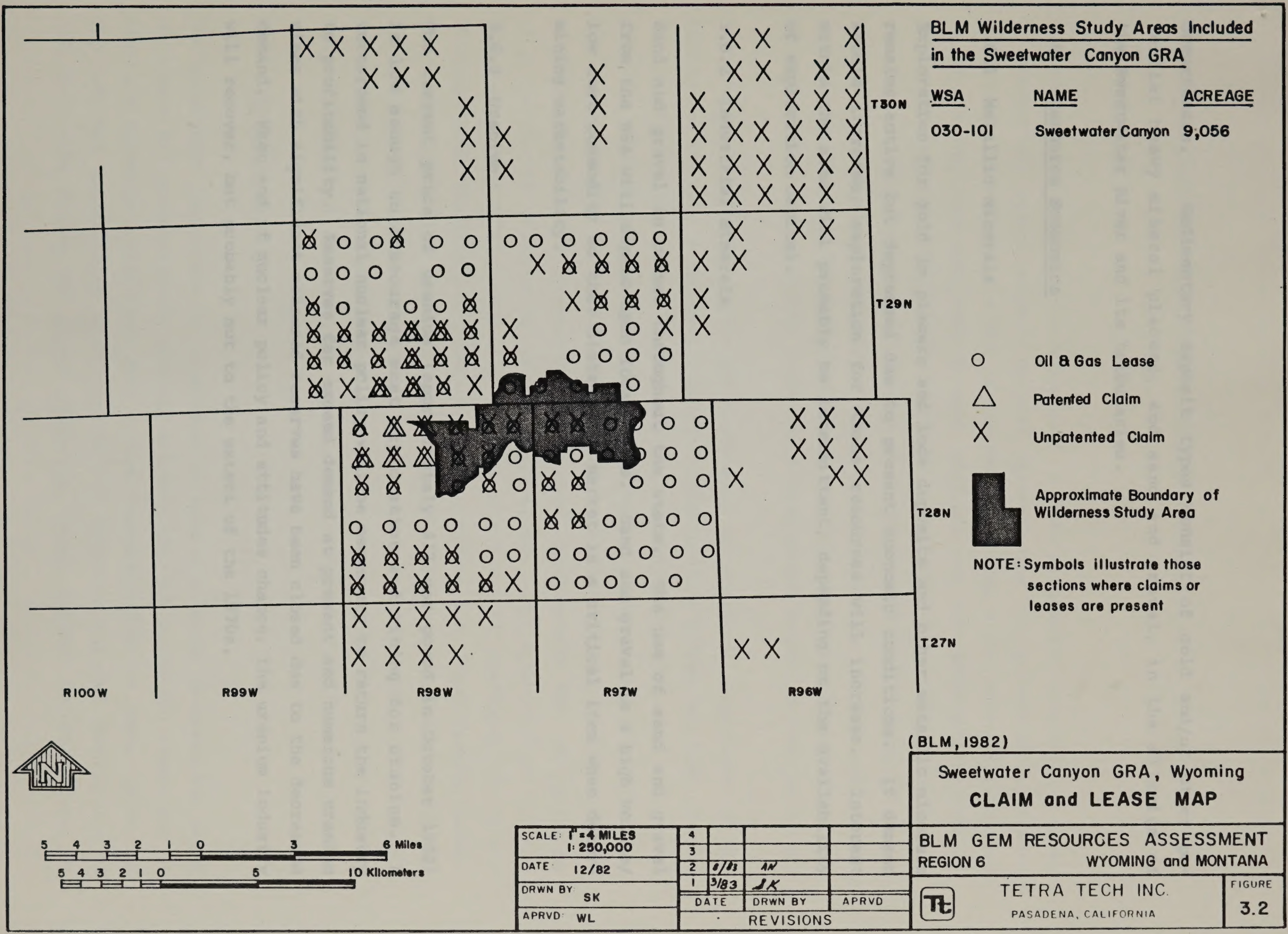
It is possible that small isolated fossil gold placers may exist in the Lower Flathead Formation. This possibility exists for three reasons: the Flathead conglomerates consist primarily of quartz pebbles derived from the Precambrian; the conglomerates were deposited in a high energy environment; and rich gold quartz veins were probably exposed in the local area during deposition of the Flathead Formation (i.e. Atlantic City-South Pass City; Lewiston District).

3.4 Land Status

Numerous unpatented lode and placer claims are found along the Sweetwater River and canyon area. All of the lands within the WSA are national resource and state lands. Figure 3.2, "Claim and Lease Map," illustrates the locations of the oil and gas leases, patented claims, and unpatented claims in the Sweetwater Canyon GRA. The oil and gas leases may reflect the idea that the Precambrian is thrust over younger rocks of the Green River Basin along the Wind River thrust. However, the Project Team considered this situation unlikely to occur within the WSA.

3.5 Deposit Types

Known and potential deposits occur within the bedrock and surficial deposits in the study area. The bedrock deposits can be divided into quartz-vein deposits in the Precambrian biotite gneiss; other vein types; pegmatite; contact metamorphic; or other types of deposits that may occur within the Precambrian but are unidentified at this time due to lack of adequate geologic mapping. Fossil gold placers may occur in the basal Flathead conglomerates as previously described. A radiometric anomaly occurs at the Precambrian-Cambrian unconformity; this anomaly indicates potential uranium or thorium



BLM Wilderness Study Areas Included in the Sweetwater Canyon GRA

WSA	NAME	ACREAGE
030-101	Sweetwater Canyon	9,056

NOTE: Symbols illustrate those sections where claims or leases are present

(BLM, 1982)

Sweetwater Canyon GRA, Wyoming

CLAIM and LEASE MAP

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FIGURE 3.2

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occurrences. Sedimentary deposit types consist of gold and/or other potential heavy mineral placers, and sand and gravel, in the alluvium of the Sweetwater River and its tributaries.

3.6 Resource Economics

3.6.1 Metallic Minerals

Exploration for gold in placers and lode deposits and other metallic minerals remains active but depressed due to present economic conditions. If demand should increase, exploration for these resources will increase. Interest within the area will probably be intermittent, depending on the availability of exploration capital.

3.6.2 Industrial Minerals

Sand and gravel is common throughout the state. The use of sand and gravel from the WSA will depend upon local needs. Sand and gravel is a high volume/low cost commodity so that distance to market is a critical item when determining marketability.

3.6.3 Uranium

The current price of uranium (approximately $17 per pound in October 1982) is low enough to discourage most exploration and mining for uranium. A turnaround in national nuclear policy will be necessary to return the industry to profitability. Reserves far exceed demand at present and numerous uranium mines with significant measured reserves have been closed due to the decreased demand. When and if nuclear policy and attitudes change, the uranium industry will recover, but probably not to the extent of the 1970s.

4.0 LAND CLASSIFICATION FOR GEM RESOURCE POTENTIAL

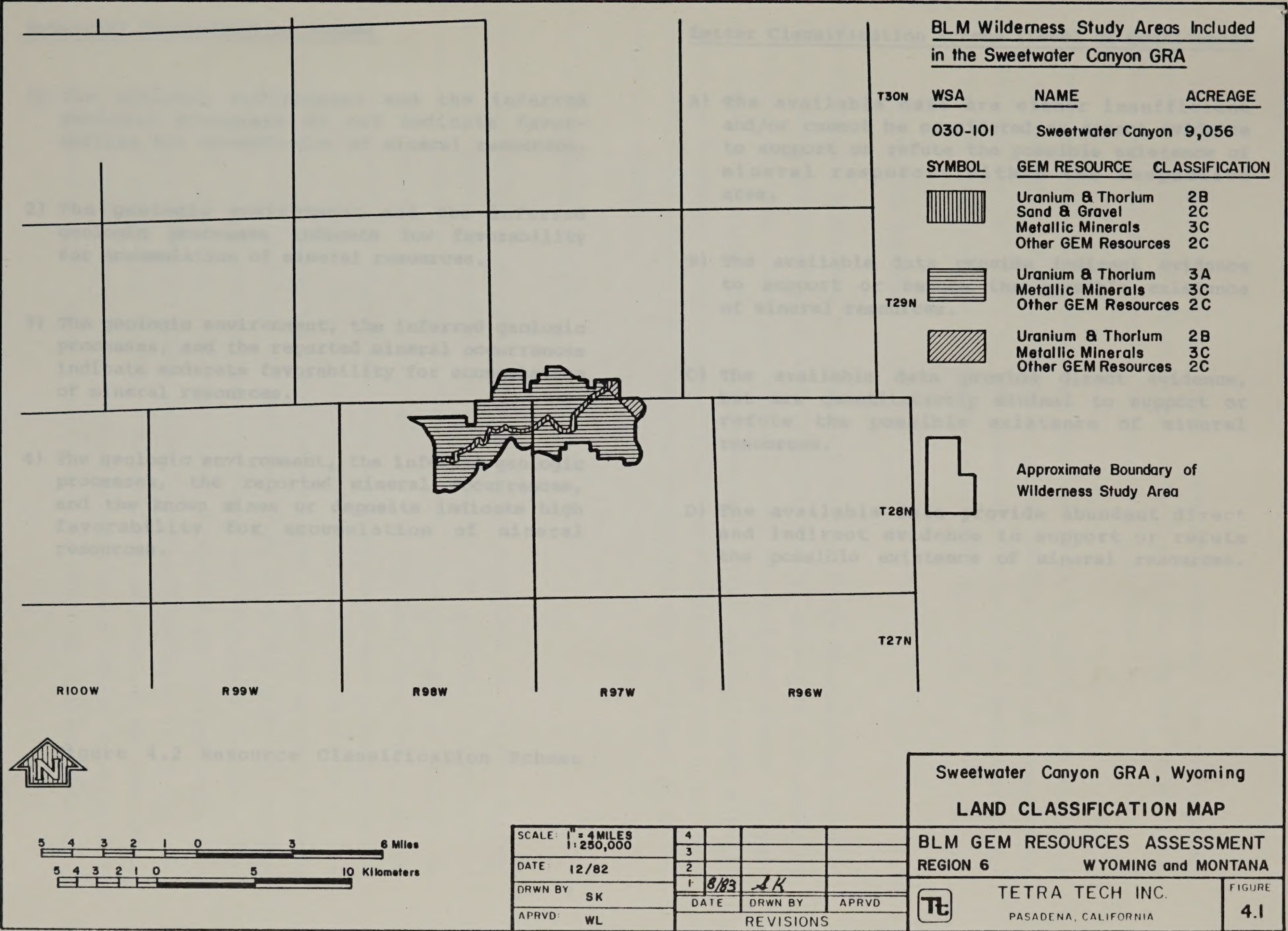
4.1 General

The Sweetwater Canyon WSA is considered to have a moderate favorability based on direct but quantitatively minimal evidence for the potential occurrence of metallic minerals. The WSA is considered to have a low favorability based on direct but quantitatively minimal evidence for the potential occurrence of industrial minerals (sand and gravel). The WSA is considered to have a moderate to low favorability based on indirect and insufficient evidence for the potential occurrence of uranium and thorium. The potential for occurrences of other GEM resources (i.e. oil, gas, geothermal, and coal) are not favorable in the geologic environment that occurs within the WSA boundary.

In order to better evaluate the occurrence or potential occurrence of resources in the GRA, a two-part resource classification scheme has been adopted as requested by contract. Each resource or potential resource within the GRA will receive an alpha-numeric classification. The number classification will range from 1 to 4, and will indicate the favorability of the geologic environment, geologic processes, and mineral occurrences for the presence of a particular resource or group of resources. The letter classification will range from A to D and will indicate the level of confidence to be associated with the numerical classification. Figure 4.1, "Land Classification Map," illustrates the areas of potential GEM resources with their assigned classifications for the WSA within the Sweetwater Canyon GRA. Figure 4.2, "Resource Classification Scheme," provides a more detailed description of the number and letter designations used in the resource classification scheme.

4.2 Metallic Minerals

The Sweetwater Canyon WSA is considered to have a moderate favorability based on direct but quantitatively minimal evidence for the potential occurrence of metallic minerals (classifed 3C). This classification is based upon the apparent but unquantified production in the Lewiston District immediately to the west, the Wilson Bar placer deposits, heavy mineral concentrations in



Sweetwater Canyon GRA, Wyoming

LAND CLASSIFICATION MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 4.1

Numerical Classification Scheme

1) The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.

2) The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.

3) The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.

4) The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

Letter Classification Scheme (Level of Confidence)

A) The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B) The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C) The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D) The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Figure 4.2 Resource Classification Scheme

the alluvium of the Sweetwater River, numerous prospects, and the abundant unpatented and patented claims that are located within the WSA (Bell, 1955; Spencer, 1916; Bayley, 1965A and B; field verification).

The favorable geologic environments that are known to exist within the study area include quartz-gold-arsenopyrite veins that occur in the Precambrian biotite gneisses (Prinz, 1974), and potential placers in the Sweetwater Canyon area and the basal Flathead Formation (field verification).

4.3 Industrial Minerals

The Sweetwater Canyon WSA is considered to have a low favorability based on direct but quantitatively minimal evidence for the potential occurrence of industrial minerals (sand and gravel). The potential occurrence of sand and gravel in the alluvium of the Sweetwater River and its tributaries is considered favorable based upon the field investigation and rock types that occur within the canyon. The Sweetwater Canyon alluvium is classified 2C for industrial minerals.

4.4 Uranium and Thorium

The Sweetwater Canyon WSA is considered to have a moderate to low favorability based on indirect or insufficient evidence for the potential occurrence of uranium and thorium (classified 3A and 2B). The presence of uranium is considered favorable in the basal part of the Flathead Formation along the unconformity with the Precambrian; this rating is based upon a similar occurrence in the Atlantic City District, and anomalous radioactivity at the contact identified during the field investigation. Because of this information, the Flathead Formation has been classified as 2B for potential uranium occurrences. The Precambrian granitic rocks are considered favorable for occurrences of pegmatitic, and other types of uranium and thorium based upon the geologic environments; these rocks have been classified as 3A for the occurrence of uranium and thorium. Finally, the alluvium of the Sweetwater River is considered to have a low favorability for the potential occurrence of uranium (classified 2B); this classification is based on indirect evidence.

4.5 Other GEM Resources

Quantitatively minimal direct evidence exists to support a low favorability classification for the potential occurrence of other GEM resources in the WSA (classified 2C). This classification is based on the geologic environment and inferred geologic processes that have been identified within the WSA.

5.0 RECOMMENDATIONS FOR FURTHER WORK

5.1 Work Recommended to Complete the Data Base

A number of investigations could be implemented to generate additional data to supplement the conclusions of this Phase I report for the Sweetwater Canyon GRA. The Sweetwater Canyon area needs significant upgrading of the geologic data base including geologic mapping and geochemical sampling. Photogeologic mapping followed by a short field check and review of data is needed to differentiate Precambrian rock types in detail and evaluate potential units and geologic environments for the occurrence of GEM resources. A reconnaissance level rock chip sampling program is needed to characterize the geochemistry of the rocks, alteration zones, and other genetic characteristics.

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